



Impact of MOVES2014 on Emission Inventories from On-road Mobile Sources

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MOVES2014

- EPA's mobile source air pollution emission model
- Estimates emissions and energy use from onroad sources at the national, county, and project scales
- Contains new rules, emission rates and activity data for onroad vehicles
- Adds nonroad emission capabilities through the incorporation of NONROAD2008
- Replaces MOVES2010b



New Rules in MOVES2014

- **Heavy-Duty Greenhouse Gas & Fuel Economy Standards: MY 2014-2018**
 - Decrease in heavy-duty energy consumption rates starting MY2014+
 - Decrease in criteria pollutant emissions as a result of mass reduction and lower aerodynamic drag and rolling resistance.
 - Increase use of auxiliary power units
- **Light-Duty Greenhouse Gas & Fuel Economy Standards: MY 2017-2025**
 - Decrease in light-duty energy consumption rates starting MY 2017
- **Tier 3 Motor Vehicle & Fuel Standards Program: MY 2017-2025**
 - Decrease in light-duty and medium-duty emission rates starting MY2017 and MY2018, respectively
 - Gasoline fuel sulfur level of 10 ppm on average starting CY2017
 - Incorporated new fuel effects model
 - Significant reductions in evaporative hydrocarbon emissions from lower diurnal and hot soak emissions, and reduce prevalence of vapor and liquid leaks



New Emission Test Programs & Data

- Fuel Effects
 - EPA Act study on gasoline fuel effects
 - EPA In-Use Sulfur Test Program
 - E85 emission effects
 - Updated renewable fuel usage and future fuel supply based on AEO2014 early release and RFS
- Evaporative Emissions
 - Ethanol, RVP, Leak Study (E-77)
 - High Evap Field Study – leak frequency
 - Running Loss Vapor Leak Study
 - Multiday diurnal testing
- Speciation
 - EPA Act fuel effects for major air toxics
 - EPA Act speciation profiles
 - Kansas City Light-duty Gasoline Study (E-69)
 - EPA Dioxin Study
 - ACES Phase I
 - Diesel Unregulated Emission Characterization (CRC-E-75)
 - HD diesel chassis testing (E-55/59)
 - CNG chassis tests (CARB studies)
- Temperature Effects
 - EPA Cold Temperature Study
- Heavy-Duty Emission rates
 - In-Use Compliance Program for heavy-duty diesels
 - Updated medium-duty gasoline emissions
 - CNG emissions from transit buses
- Population and Activity
 - Vehicle population from R.L. Polk for 2011
 - FHWA vehicle miles traveled (VMT) estimates
 - Vehicle sales and VMT projections, including flex-fuel vehicle penetrations (AEO2014)
 - National average speed distribution using GPS data
 - Truck weights based on Weigh-in-Motion data
 - New driving cycles for heavy-duty vehicles at low and high speeds



MOVES2014 vs. MOVES2010b

- **Goal: Comparison with equivalent user-inputs**
- Isolate differences in emission rates, fuel effects, temperature adjustments, internal vehicle population and activity information
- 3 urban county runs in 2011 and 2030
 - Used state-supplied National Emission Inventory (NEI) inputs
 - Projections to 2030 using MOVES2014 growth assumptions, and age distribution tool

City	Description	Combination Truck Fraction of VMT (2011-2030)	Diesel Properties (2011/2030)	Gasoline Properties (2011/2030)	E10 Market Share% in 2011	E15 Market Share% in 2030	E85 Market Share % in 2030
A	Southeast City	4.0%/4.6%	<u>Sulfur:</u> 15 ppm <u>Biodiesel:</u> 0/5%	<u>Sulfur:</u> 30 / 10 ppm <u>RVP:</u> E0: 7-12 psi E10: 8-13 psi E15: 7-12 psi <u>Aromatics:</u> E0: 23-28% E10: 17-26% E15: 15-24%	91%	18%	3.1%
B	Midwest City	6.1%/7.1%			100%	20%	3.9%
C	West, High Altitude City	2.7%/3.2%			81%	15%	3.5%

MOVES2014 vs. MOVES2010b Model Inputs

Equivalent User-Inputs

Vehicle Miles Traveled by HPMS Vehicle Type

1. *Motorcycles*
2. *Light-duty vehicles*
3. *Buses*
4. *Single-unit trucks*
5. *Combination trucks*

Vehicles Miles Traveled by Road Type

(Rural, Urban, Restricted Access, Unrestricted Access, Freeway Ramps)

Temporal VMT Distribution

(Month, Day, Hour)

Vehicle Population by MOVES Source Type

Age Distributions by MOVES Source Type

Average Speed Distribution

Inspection/Maintenance Program

Fuel Supply/Fuel Formulation

Meteorology

Key Default Values That Differ

VMT of the 13 MOVES Source Types within HPMS Vehicle Types

e.g. Source Types within Light-duty vehicles

1. *Passenger Cars*
2. *Passenger Trucks*
3. *Light Commercial Trucks*

Default Vehicle Characteristics within MOVES Source Types

1. *Regulatory Class Distributions*
(e.g. Class 2b/3 vs. Class 4/5 trucks within Single-unit Trucks)
2. *Fuel Type Distributions*
(e.g. Gasoline, E85, Diesel Vehicles within Passenger Cars)

Renewable Fuel Usage

E85 and Biodiesel usage only specified in MOVES2014 runs

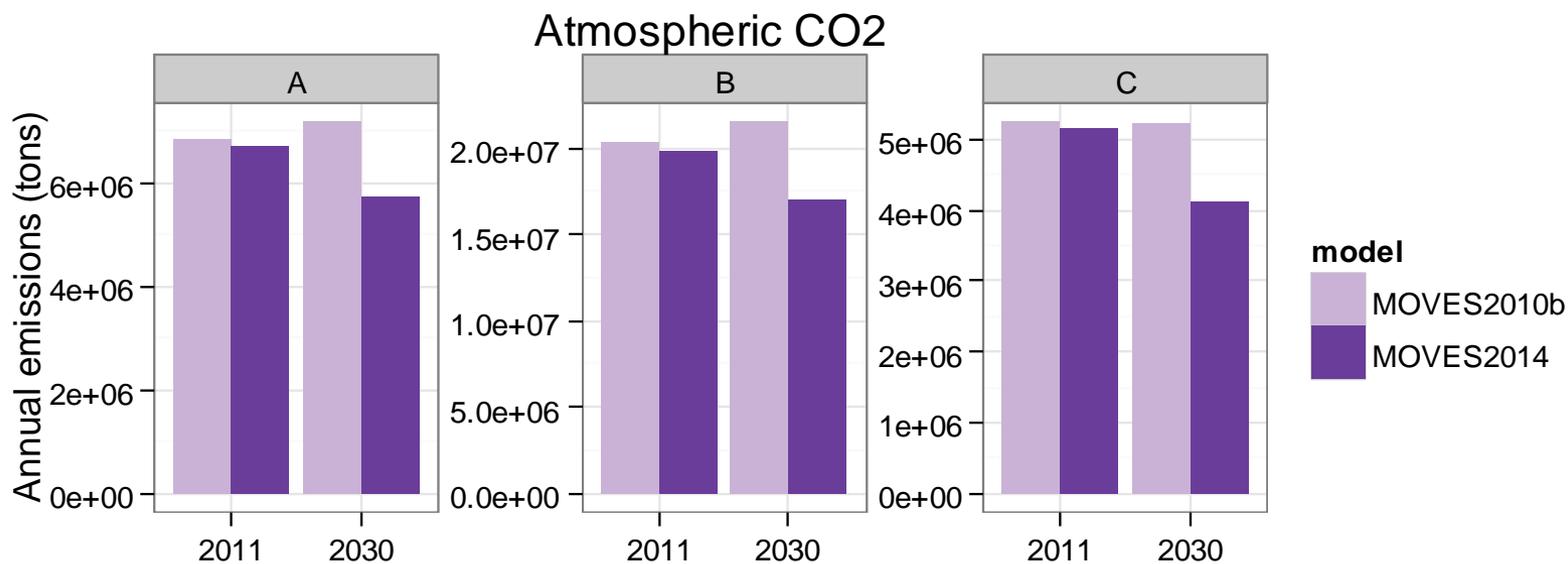
Geographical Allocation of Extended Idling

Allocated to rural VMT in MOVES2014. Extended idle use for 3-cities decreases from 85% to 100%.

Auxiliary Power Units

No APU usage in MOVES2010b. MOVES2014 allows user input for extended idle and APU usage.

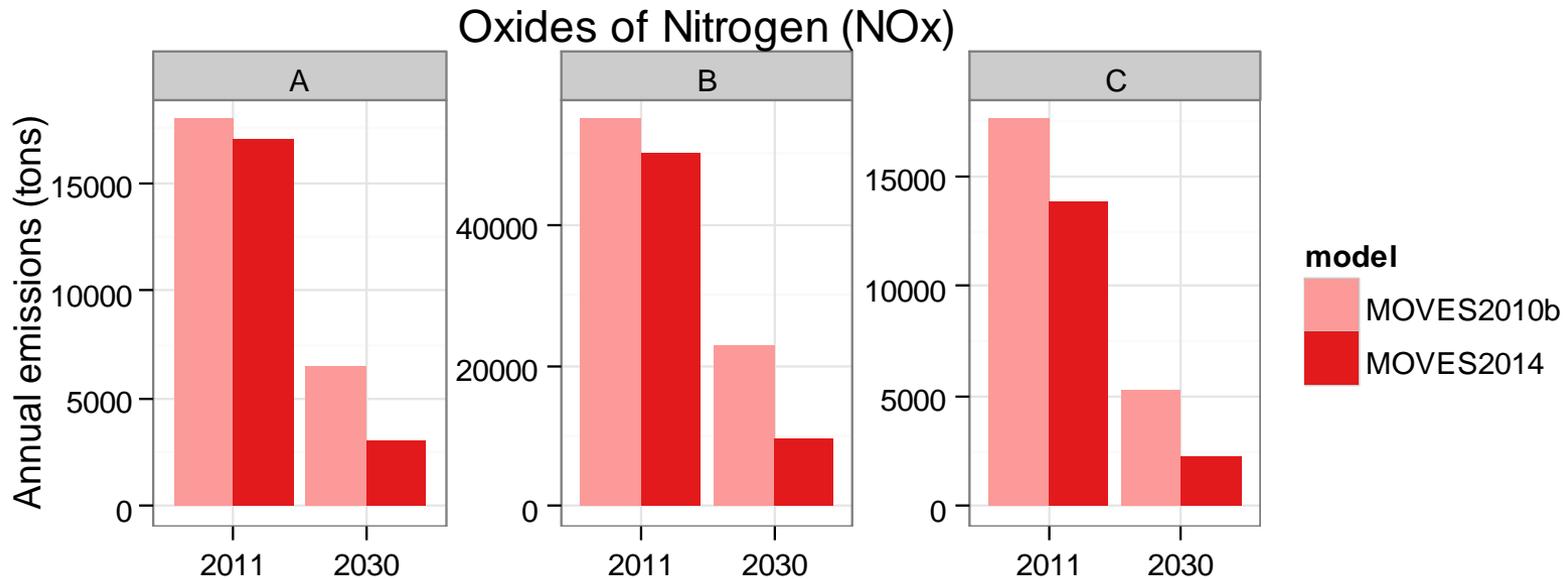
Highway-Source CO₂



- 2011
 - Reduced heavy-duty truck weights
 - Changes in vehicle characteristics within HPMS classes
- 2030
 - Large reductions due to LD and HD GHG regulations



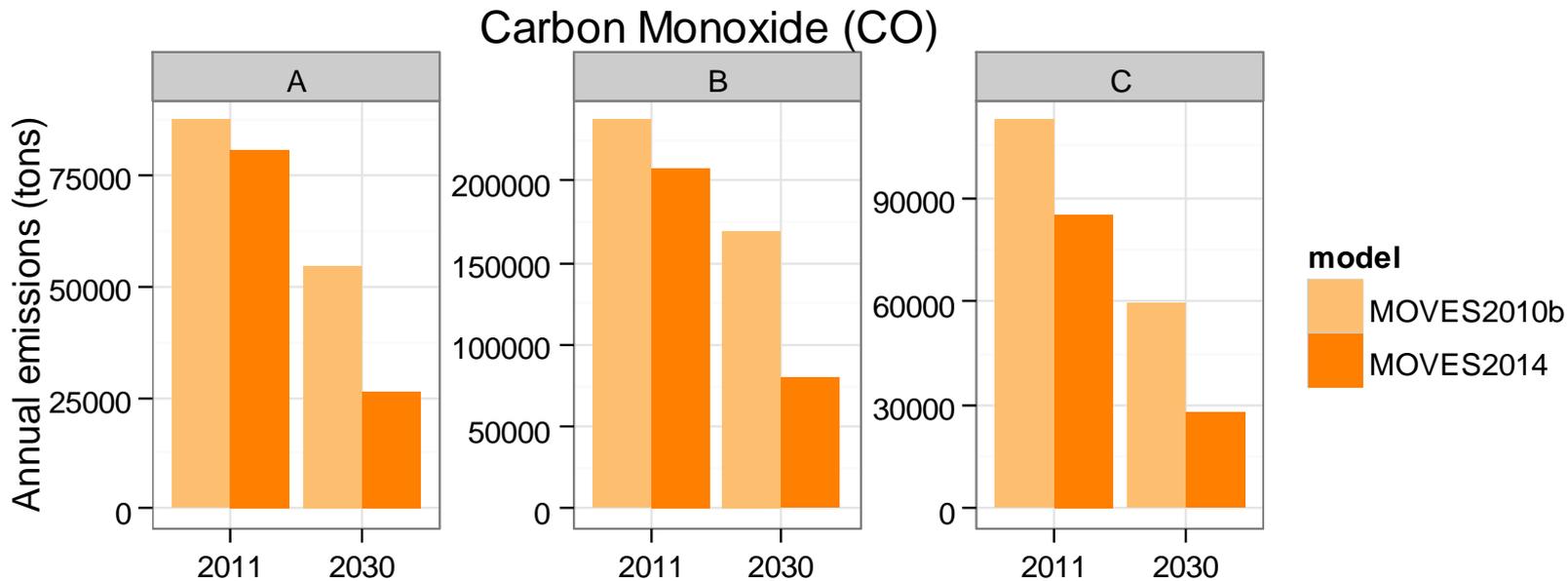
Highway-Source NOx



- 2011
 - **Increase** in heavy-duty diesel NOx running emission rates (2007-2009)
 - **Less extended idling in urban areas**
 - Reduced heavy-duty truck weights
 - Decrease in light-duty diesel NOx emission rates (**City C**)
 - Updated gasoline fuel effects (2001+)
- 2030
 - Large reductions due to Tier 3 and HD GHG regulations



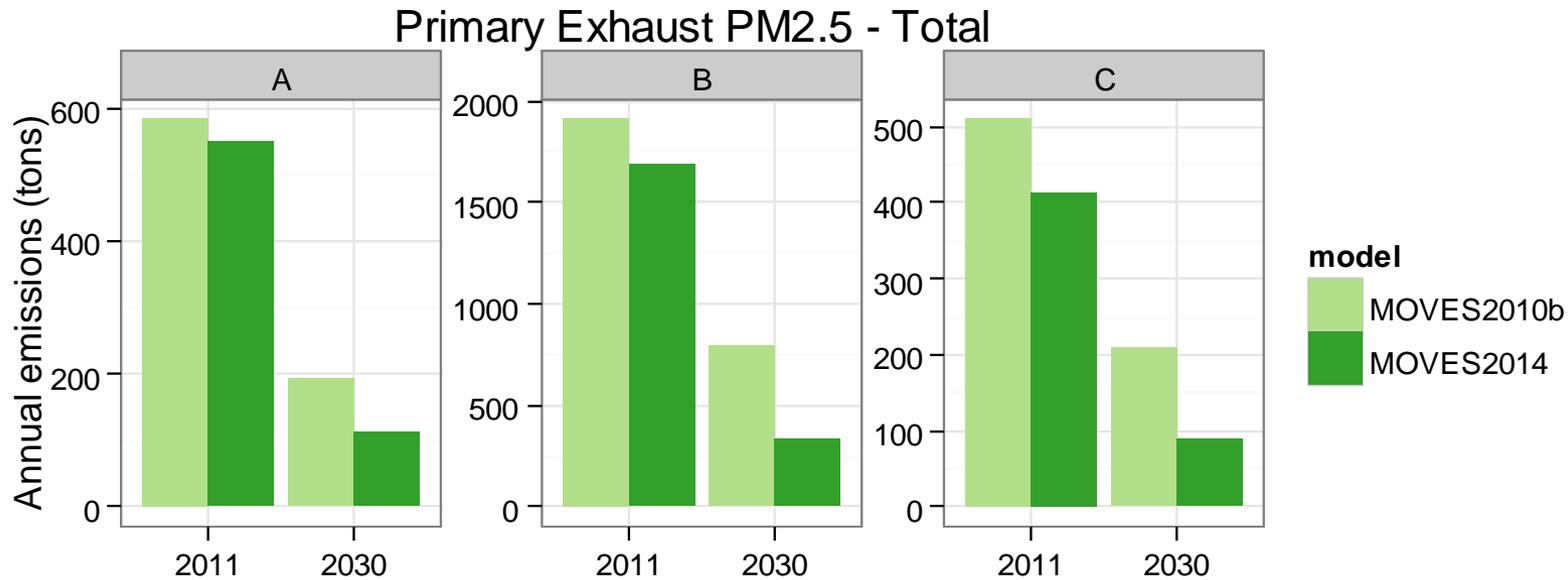
Highway-Source CO



- 2011
 - Updated gasoline fuel effects (2001+)
 - Higher temperature sensitivity for cold starts (1986-1993)
 - Lower temperature sensitivity for cold starts (2001+)
- 2030
 - Large reductions due to Tier 3 and HD GHG regulations



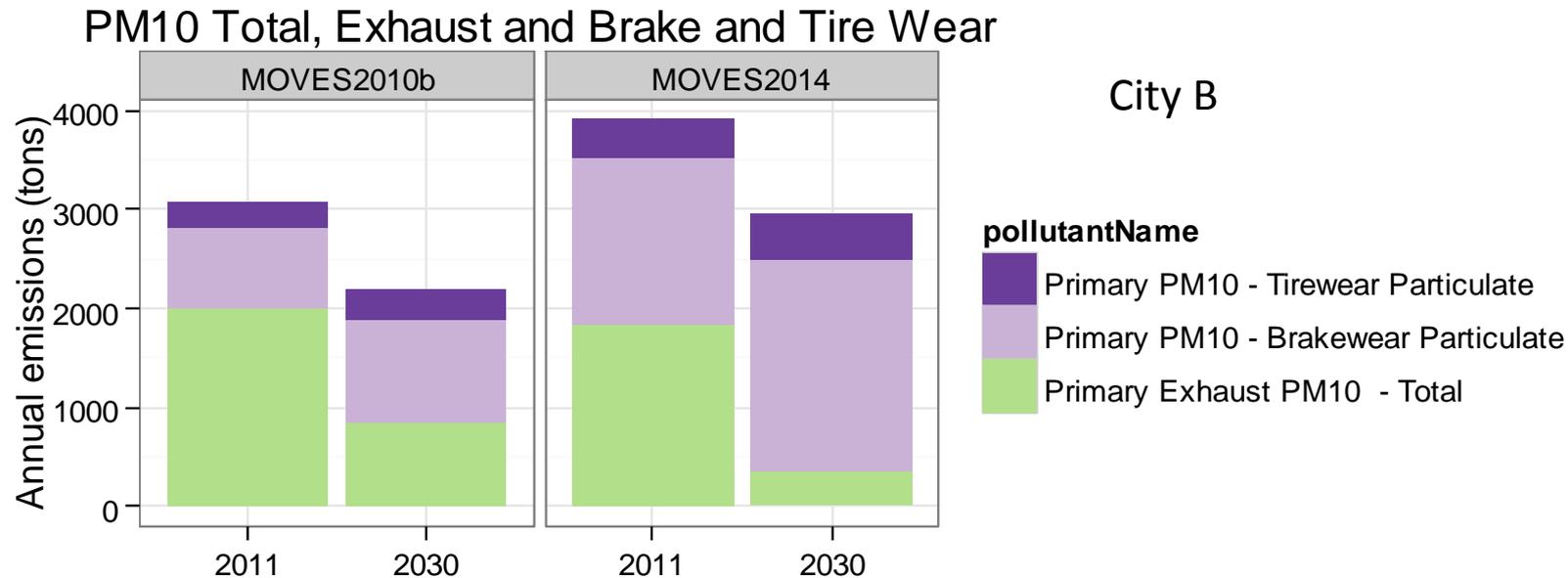
Highway-Source Exhaust PM2.5



- 2011
 - **Lower temperature sensitivity for newer gasoline vehicles (2004+)**
 - Decrease in light-duty gasoline and diesel emission rates
 - Reduced truck weights
 - Less extended idling in urban areas
- 2030
 - Large reductions due to Tier 3 regulation



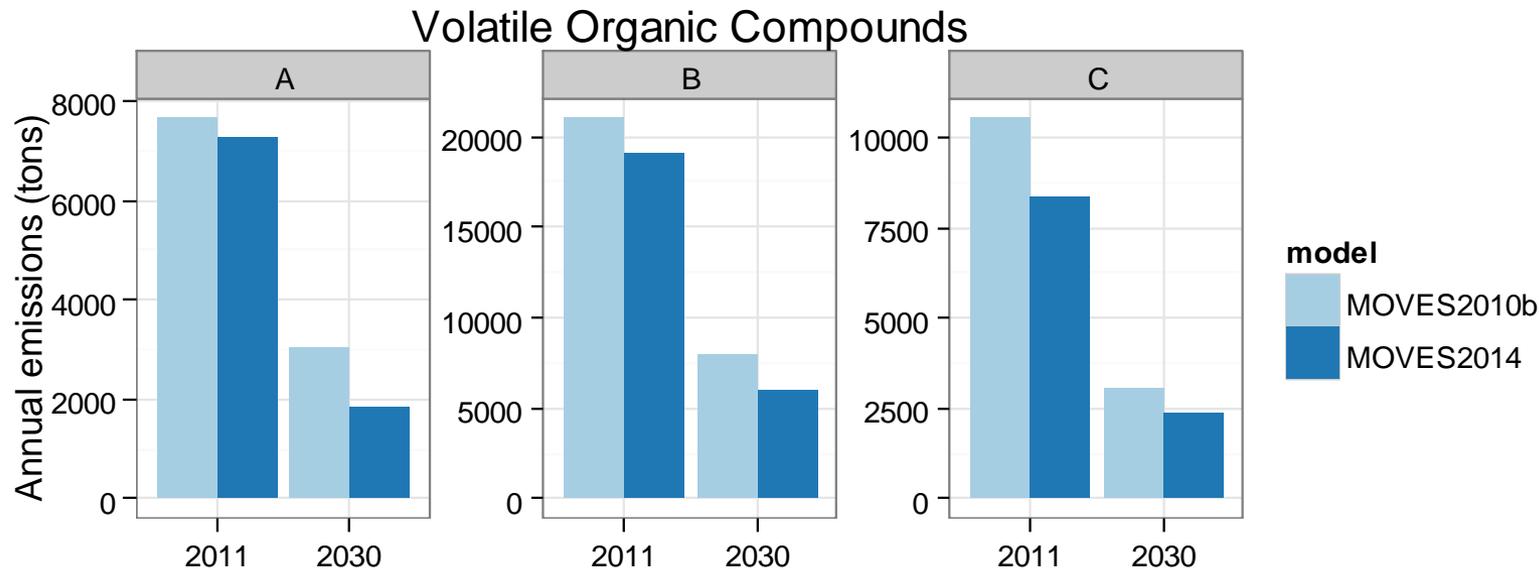
Highway-Source Total PM10



- Increase in Total PM10 in MOVES2014 compared to MOVES2010b
- Coarse fraction (PM10-PM2.5) increased significantly for brake and tirewear in MOVES2014



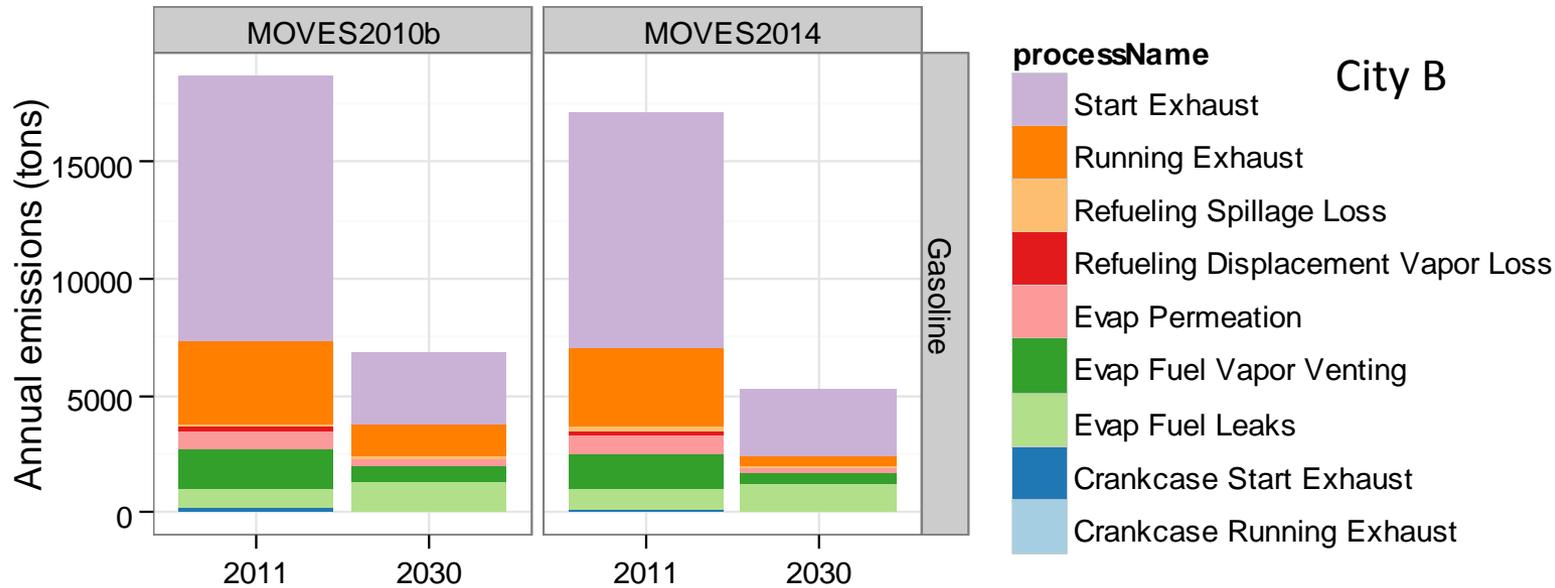
Highway-Source Exhaust and Evaporative VOC



- 2011
 - Updates to evaporative and fuel effects for gasoline vehicles
- 2030
 - Reductions due to Tier 3 regulation
 - **Increase** in temperature sensitivity for cold starts for newer gasoline vehicles (MY 2010+)



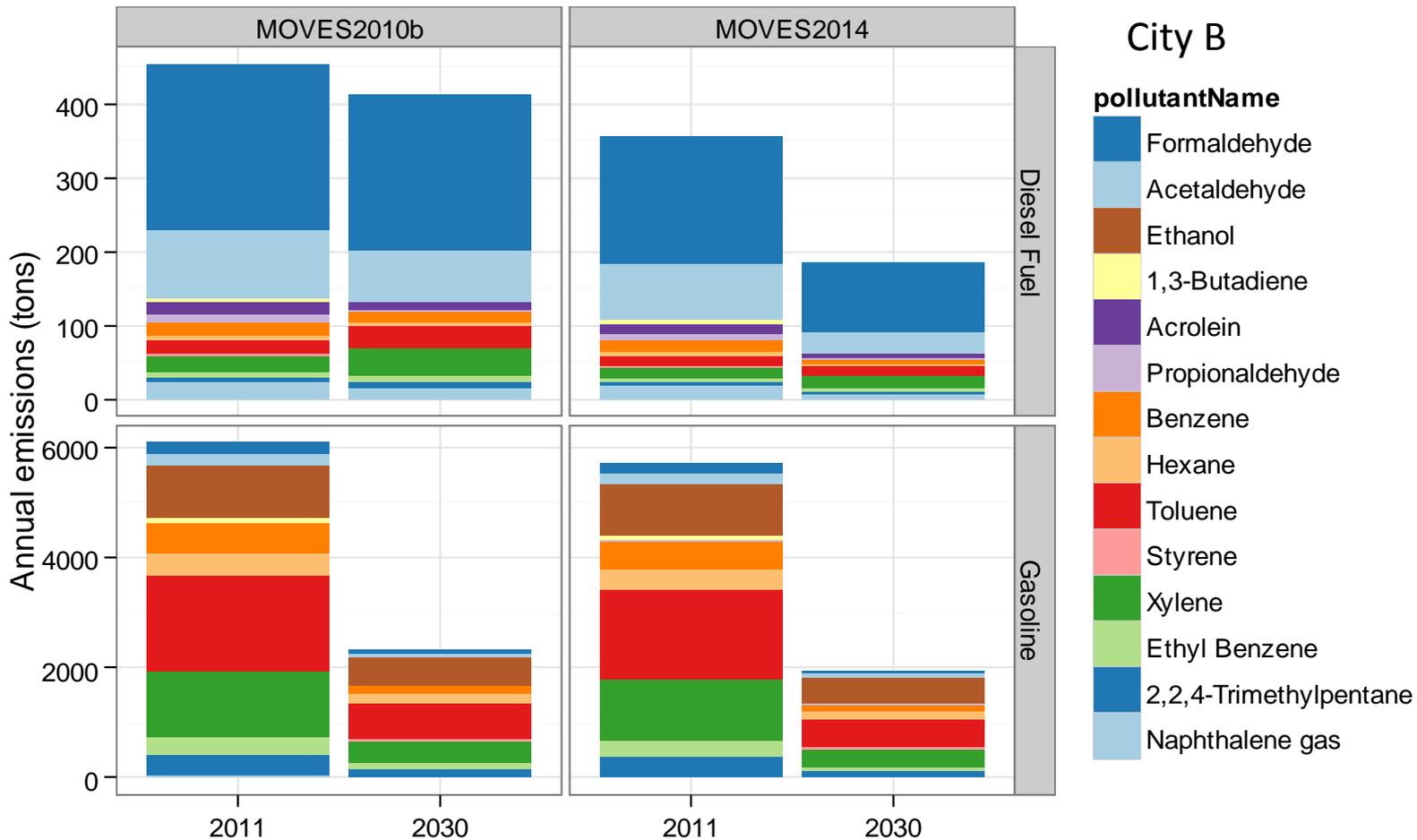
VOC Emissions from Gasoline Vehicles by Process



- 2011
 - Similar contributions of VOC from exhaust and evaporative emission processes between MOVES versions
- 2030
 - MOVES2014 has lower contribution of VOC from running exhaust



Composition of Gaseous Toxic Emissions – Gasoline and Diesel



Individual gaseous toxic emissions generally follow VOC trends



Observations

- With equivalent inputs, MOVES2014 estimates lower emissions in urban areas
- Larger reductions typically observed for future years
 - Due to projected impact of EPA regulations
- Actual differences between MOVES2010b and MOVES2014 will vary based on other local model inputs
 - Revised inputs can create greater changes in the emissions than changes w/ MOVES2014



What's next?

- Short-term: MOVES2014a
 - Target: Available for 2014 NEI
 - Adding NONROAD air toxics
- Long-term: Planning for major update
 - Looking for user feedback on priorities
 - Email: mobile@epa.gov



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